

## REMARKS

Claims 1-2, 4-5, and 24 are currently pending in the application. Claims 6-23 have been withdrawn due to a restriction requirement made by telephone on April 4, 2007. Claims 1 and 24 are in independent form.

The amendment filed December 26, 2007 is objected to under 35 U.S.C. §132(a) because it introduces new matter into the disclosure. The Office Action holds that the added material that is not supported in the original disclosure is as follows: the description of electrocatalytic polymerization in paragraphs [0022], [0023], [0024], [0027], [0031], [0034], [0044], and [0046]. In response thereto, Applicants refer to the previously submitted Declaration and the Declaration submitted herein. Figure 2 of the present invention shows that the only possible method of applying the metal complex on the carbon article is through reductive electropolymerization. One skilled in the art would certainly recognize that this process was used, and thus amending the specification to describe what is evident in the Figure is not new matter.

The claims in the current application have nothing to do with cyclic voltammetry, but pertain to the invention of a new method for uniform coating of a metal surface onto a substrate, a carbon article for example, by reductive electropolymerization. The cyclic voltammetric technique was discovered more than a century ago, and was neither the discovery by Verbrugge nor by the Applicants. Verbrugge deposited platinum metal on carbon article from platinum salts by conventional electrodeposition, i.e., applying voltage to reduce platinum(II) to platinum metal. The range of voltage selection, voltage cycling, scan speed, etc. are all part of the conventional cyclic voltammetry techniques, not Verbrugge's discovery. The current application deals with the electropolymerization of a metal complex on a carbon support to layout a uniform coating first by applying voltage and then by reducing the complex to metal on to the surface.

The evidence for electropolymerization is clearly displayed in Figure 2. Skilled workers in the field would immediately conclude the existence of electropolymerization based on the features of current-voltage in repeated cycles displayed in Figure 2. Many electrochemists have published similar features as displayed in Figure 2 as the clear evidence for electropolymerization. Two articles on the vast literature on electropolymerization, Abruna et al. (Journal of the American Chemical Society, 1981, vol 103, 1-5, and Gurr & Anson ( J. Phys. Chem. 1987, vol 91, 4037-4043) are attached where several diagrams similar to Figure 2 are displayed as the evidence for electropolymerization. Reconsideration of the objection is respectfully requested.

Claims 1, 2, 4, 5, and 24 stand rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement. Specifically, the Office Action holds that the amendments of the claims introduce new matter and the amendment is not considered to be a correction of an obvious error. The Office Action holds that there is nothing in Applicants' specification to indicate that the process of applying cyclic voltammetry is not conventional. In response thereto, Applicants again refer to the previously submitted Declaration and the Declaration submitted herein. Applicants have amended the claims to reflect the unique properties of reductive electropolymerization. A polymerizable metal is required to be used, and a step-wise increase in current is effected until the polymerizable metal coating is saturated on the carbon article. Such a step-wise increase in current does not occur with conventional cyclic voltammetry as in Verbrugge. The only possible way that this increase would occur, as described in the previously submitted Declaration, would be through electropolymerization. In other words, Figure 2 of the present invention cannot show another process besides electropolymerization, and thus the amendments to the claims and specification are obvious corrections.

Claims 1-5 and 24 stand rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,284,571 to Verbrugge. Specifically, the Office Action holds that the Verbrugge patent is directed to a method of making electrodes for electrochemical cells and discloses a substrate that is a gas-diffusion electrode prepared in the form of an essentially planar carbon electrode. The substrate was contacted with a 10 mM  $\text{Pt}(\text{NH}_3)_4\text{Cl}_2$  solution, a voltage was applied, and platinum was deposited. The Office Action holds that Verbrugge applied electrodeposition by voltammetry. Reconsideration of the rejection under 35 U.S.C. § 102(b), as anticipated by Verbrugge, as applied to the claims is respectfully requested. Anticipation has always been held to require absolute identity in structure between the claimed structure and a structure disclosed in a single reference.

In Hybritech Inc. v. Monoclonal Antibodies, Inc., 802 F.2d 1367, 231 U.S.P.Q. 81 (Fed. Cir. 1986) it was stated: "For prior art to anticipate under §102 it has to meet every element of the claimed invention."

In Richardson v. Suzuki Motor Co., Ltd., 868 F.2d 1226, 9 U.S.P.Q.2d 1913 (Fed. Cir. 1989) it was stated: "Every element of the claimed invention must be literally present, arranged as in the claim."

Verbrugge discloses three methodologies to electrodeposit metal by using positively charged metal species. The abstract of Verbrugge clearly states that "The method of the invention deposits positively charged metal species, preferably platinum-ammine, at sites where negatively charged sulfonic acid groups of the SPE are in contact with carbon". These methodologies are then elaborated by providing three examples. In example 1, 0.01 M  $\text{Pt}(\text{NH}_3)_4\text{Cl}_2$  (a cationic complex) was used by setting a potential at -2 V vs. Ag/AgCl electrode. In example 3, Verbrugge deposited platinum on a glassy carbon surface by rotating disk method with a rotating speed of 1000 rotations per minute by scanning potential from 0 to -0.8 V. Example 3 in Verbrugge's invention was

used to document that these electrodeposited materials show hydrogen evolution at potential more negative than -1 V, breakdown of solvent at low metal concentrations, and pointed out the limitation of the use of low concentration of metal cation for electrodeposition. In example 4, a -0.75 V fixed potential was used to electrodeposit platinum again from cationic 10 mM  $\text{Pt}(\text{NH}_3)_4\text{Cl}_2$  solution. In fact, half an hour deposition yielded only 0.1 mg/cm<sup>2</sup> platinum. In other words, Verbrugge discloses conventional electrodeposition through rotating disk electrode voltammetry, and controlled potential electrolysis.

In contradistinction, the present invention requires the use of cyclic voltammetry to electrocatalyze polymerization (i.e. electropolymerization) of anionic, cationic, or neutral platinum complexes on carbon substrates followed by reduction (reductive electropolymerization) to form a uniform thin-film of metal with variable loadings from 0.03 mg/cm<sup>2</sup> to 0.2 mg/cm<sup>2</sup>. Applicants have amended the presently pending claims to more accurately describe the invention, i.e. coating a carbon article with a polymerizable metal by reductively electropolymerizing the polymerizable metal on the carbon article through cyclic voltammetry, and forming a polymerized metal coating on the carbon article by effecting a step-wise increase in current until the polymerizable metal is saturated on the carbon article. The technique of cyclic voltammetry has long been known to electrochemists; however, Applicants have used herein a nonconventional method that was previously not expected to work. Applicants used this technology to electrocatalyze platinum metal complexes to form polymeric species to uniformly coat carbon substrate followed by reduction to make a thin-film. This technique is characterized by a large jump in current, i.e. ***a step-wise increase in current is effected until the polymerizable metal is saturated on the carbon article, i.e. until electropolymerization on the carbon article is complete***, as evidenced by the leveling-off of the current in Figure 2 after a few cycles and further explained below. This step is not present in Verbrugge.

See MPEP 2163.07 II: "An amendment to correct an obvious error does not constitute new matter where one skilled in the art would not only recognize the existence of the error in the specification, but also recognize the appropriate correction. *In re Oda*, 443 F.2d 1200, 170 USPQ 268 (CCPA 1971)."

See also MPEP 2163 II A 3(a): "An applicant may show possession of an invention by disclosure of drawings or structural chemical formulas that are sufficiently detailed to show that applicant was in possession of the claimed invention as a whole. See, e.g., *Vas-Cath*, 935 F.2d at 1565, PATENTABILITY **2163** 2100-179 Rev. 6, Sept. 2007 19 USPQ2d at 1118 ("drawings alone may provide a 'written description' of an invention as required by Sec. 112\*"); *In re Wolfensperger*, 302 F.2d 950, 133 USPQ 537 (CCPA 1962) (the drawings of applicant's specification provided sufficient written descriptive support for the claim limitation at issue)."

Although, the present application did not specifically use the terminology "electrocatalyzed polymerization" or "electropolymerization", it should be obvious to one skilled in the art from the body of the figures, data, and evidence provided in the present application that the methodology is not conventional electrodeposition by conventional voltammetry as described in Verbrugge, but rather electrocatalyzed polymerization followed by reduction. See the attached Declaration by Applicant Rathindra Bose. Thus, Applicants have amended the claims and specification to more accurately describe the invention, without adding any new matter, as the modifications were inherently present to one skilled in the art.

For example, Figure 2 in the present application clearly demonstrates the deposition technique is based on electrocatalysis leading to polymerization of platinum complexes on carbon surfaces. In this Figure, the increase in peak current in successive cycles, as indicated by cycles 1, 2, 3 etc., shows dramatic increase in current compared to latter cycles. There is no reduction peak at -0.7

V for the first cycle, the distinct formation of the reduction peak became visible in cycle 3. This peak is due to formation a thin uniform platinum film due to electropolymerization which is the active electrocatalyst. This modified carbon surface coated with platinum thin film is the active electrode for the reduction of phosphate blue used in Figure 2 since a carbon electrode alone does not reduce the phosphate blue species.

For conventional electrodeposition of platinum, one would expect a slow growth in peak at -0.7 V, and the current in successive cycles would depend on the bulk concentration of the platinum phosphate complex. Therefore, the change in the magnitude of current between two successive cycles would either be constant (where the changes in bulk concentration of platinum complex in solution is negligible due to small amount of electrodeposition) or less due to the depletion of the substrates. This is due to the fact that the current in cyclic voltammetry, or linear voltammetry, linearly depends on the concentration of the electro-active species and square root of the scan speed as listed in the patent application.

Furthermore, when a thin-film formation is complete in the present invention, very little changes in peak current at -0.7 V were apparent beyond 5<sup>th</sup> cycle, confirming the behavior of microelectrode in cyclic voltammetry that no further changes in the electrode surface were taking place and that the bulk electro-active species is quasireversibly reduced and oxidized without significantly depleting its concentration. The above observations can only be described by a process in which platinum complexes in solution were polymerized at the carbon surface and then were reduced to platinum on the same surface by application of potential. Once carbon surface is covered with a platinum thin-film, such polymerization no longer takes place since no changes in

the voltammograms were observed. Therefore, **this process can best be described by reductive electropolymerization.** Applicants have amended the independent claims to require a polymerizable metal and that the step-wise increase in current is effected until the polymerizable metal is saturated on the carbon article. These characterizing features of reductive electropolymerization are not present in Verbrugge. In fact, following the submission of the present patent application, Applicants have published an article entitled, "Electrocatalytic reduction of platinum phosphate blue on carbon surfaces: A novel method for preparing fuel cell electrode" which appeared in the Journal of Power Sources, 2006, vol.157, pp 188-192. A copy of the article is also attached in the Declaration. See page 191 of the Discussion regarding reductive polymerization.

There are further differences between Verbrugge and the present invention. The present invention's electropolymerization can be applied to anionic complexes whereas Verbrugge only discloses cationic complexes; two such examples are shown in Table 1 in the application,  $\text{Pt}_2(\text{NH}_3)_2(\text{PO}_4)_2^{2-}$  and  $\text{PtCl}_4^{2-}$ . Applicants used forward scan (cathodic scan) to form thin-films by reductive electropolymerization, and the reverse scans were used to reoxidize any platinum that might have deposited due to conventional electrodeposition. Such conventional electrodeposition by constant current or potential scan is detrimental to the surface. Applicants' technology can be applied in lower concentrations; there is not a low concentration limit. Applicants' methodology is applicable to any complexes (cationic, anionic, or neutral) as long as these complexes can be polymerized at the carbon surfaces.

Therefore, since the Verbrugge patent does not disclose coating a carbon article with a polymerizable metal by reductively electropolymerizing the polymerizable metal on the carbon article through cyclic voltammetry, and

forming a polymerized metal coating on the carbon article by effecting a step-wise increase in current until the polymerizable metal is saturated on the carbon article as set forth in the presently pending independent claims, the claims are patentable over the Verbrugge patent and reconsideration of the rejection is respectfully requested.

The remaining dependent claims not specifically discussed herein are ultimately dependent upon the independent claims. References as applied against these dependent claims do not make up for the deficiencies of those references as discussed above, and the prior art references do not disclose the characterizing features of the independent claims discussed above. Hence, it is respectfully submitted that all of the pending claims are patentable over the prior art.

It is respectfully submitted that the present amendment places the application in condition for allowance as it removes all remaining issues in dispute. Specifically, the amendment does exactly what is suggested in the Office Action, that is method steps are clarified to distinguish conventional cyclic voltammetry from reductive electropolymerization of the present invention. The claims have been made no broader in scope thereby requiring no further searching and raising no new issues. In fact, all claims now include limitations of previously pending claims and were therefore previously searched. Since there is no prior art cited against any of these claims, it is respectfully submitted that all of the claims are in condition for allowance.

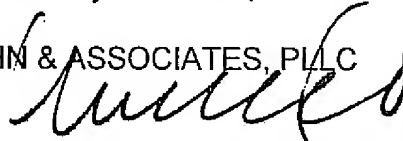
In view of the present amendment and foregoing remarks, reconsideration of the rejections and advancement of the case to issue are respectfully requested.



The Commissioner is authorized to charge any fee or credit any overpayment in connection with this communication to our Deposit Account No. 11-1449.

Respectfully submitted,

KOHN & ASSOCIATES, PLLC



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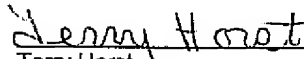
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